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An observational study of conflicts between cyclists and pedestrians in the city centre

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Abstract

City centres have large volumes of pedestrians and motorised traffic and increases in walking and cycling could potentially lead to more pedestrians and cyclists being injured. In this study, observers recorded cyclist characteristics, number of pedestrians within 1m and 5m radius and type of conflict (none, pedestrian, vehicle) for 1,971 cyclists in 2010 and 2,551 cyclists in 2012 at six locations in the Brisbane Central Business District. Only 1.7% of cyclists were involved in conflicts with a motor vehicle or pedestrian and no collisions were observed. Increased odds of a pedestrian-cyclist conflict was associated with: male riders, riders not wearing correctly fastened helmets, riding on the footpath, higher pedestrian density (within 1m but not within 5m), morning peak and 2-4 pm (compared with 4-6 pm), two-way roads, roads with more lanes, higher speed limits, and yellow marked bicycle symbols on the road.

Keywords

Active travel, Bike share, Traffic conflicts, Cyclist, Pedestrian, Public bicycle.

Introduction

Many jurisdictions around the world promote walking and cycling for health and transport reasons. Both walking and cycling are especially suited to short distance trips, and many trips in city centres are short trips. However, city centres have large volumes of pedestrians and motorised traffic and increases in walking and cycling could potentially lead to more pedestrians and cyclists being injured. Much previous research has focused on the high severity of injuries often incurred when motor vehicles collide with pedestrians and cyclists but there is increasing concern from pedestrians about the threats they perceive from cyclists. European studies [1, 2] have reported that elderly pedestrians consider cyclists riding on the footpath to be a hazard and a Japanese study [3] has shown that the elderly and young children rate scenes of pedestrian and bicycle conflicts as more risky than do university students. Ratings of risk appeared to be influenced by physical separation, not speed, with high ratings when bicycles were less than 0.75 metres from the pedestrian, dropping to low ratings when the bicycles were more than 1.5 metres away. Analyses of potential energy transfer also support this concern. Grzebieta, McIntosh [4] point out that the ratio of kinetic energy between an adult cyclist and a 50th percentile pedestrian walking at 5 km/h is similar to that between a 1.5 tonne car in a 50 km/h zone and an adult cyclist riding at 30 km/h in the same direction [4]. A German study [5] cited national statistics showing that fatal pedestrian-bicycle collisions were rare outcomes but that the cyclist was considered to be at fault in about two-thirds of all pedestrian-bicycle collisions. The authors reported detailed reconstructions of three fatal pedestrian-bicycle collisions which involved teenaged riders on mountain bikes colliding with frail, elderly pedestrians.

Despite these concerns, there is little objective data available regarding the prevalence of injury to pedestrians resulting from collisions with cyclists. Australian hospital data for the 2008-2009 financial year show that 40 pedestrians were coded as having been injured in a traffic accident (either on the footpath or on the road) where the counterpart was a pedal cyclist [6], corresponding to 1.5% of all hospitalised pedestrians. In the same period, 33 cyclists were hospitalised as a result of a traffic accident where the counterpart was a pedestrian or animal, corresponding to 0.6% of all hospitalised pedal cyclists. Chong, Poulos [7] compared the frequency and severity of injuries arising from bicycle–motor vehicle and bicycle–pedestrian collisions in NSW over a five-year period. Most cyclists admitted to hospital were male and injured in collisions with motor vehicles (n=784). Among females aged 65 and older, there were less than five cyclists admitted to hospital resulting from a collision with a pedestrian or animal, less than five cyclists admitted as a result of a motor vehicle collision and 20 admitted following a collision with a cyclist. The corresponding figures for males aged 65 and older were less than 5, 13 and 46. Of the 163 pedestrians hospitalised resulting from collisions with cyclists, 72 resulted from a non-traffic accident and 48 were unspecified. The severity of injury was greater for people aged 65 and older, regardless of whether they were a pedestrian in a collision with a cyclist or a cyclist in a collision with a pedestrian or a motor vehicle [7].

Cycling on the footpath is one way of separating cyclists from motor vehicle traffic, and is permitted throughout Queensland, Tasmania and the Australian Capital Territory for adults and children unless otherwise signed. In other jurisdictions, adults are only permitted to ride of the footpath if accompanying a child aged 12 years or less. Cycling on footpaths arguably allows cyclists a safer option in locations where the rider perceives the road and traffic conditions to be too dangerous. Prohibiting cycling on the footpath appears to be based on concerns about cyclists posing a threat to pedestrians on footpaths, and the potential to increase conflict between cyclists and motor vehicles at driveways and intersections.

One of the few studies of cyclist-pedestrian crashes where location of cycling was known [8] examined admitted patients records of eight Victorian hospitals. During the period 1 April to 20 December 1986, only two pedestrians were injured as a result of a collision with a cyclist on a footpath (and two potential additional cases where actual location of the collision could not be determined). While the study found that pedestrians sustaining serious injuries as a result of a collision with cyclists on the footpath is a relatively small problem, there was no way of determining the likelihood of pedestrians sustaining non-serious injuries that do not require hospitalisation or determining the reduction in pedestrian amenity from permitting cycling on footpaths.

A more recent survey of more than 2,500 Queensland adult cyclists [9] reported that about 5% of the distance ridden occurred on the footpath and about 5% of self-reported cyclist injury crashes occurred on footpaths. The majority of footpath crashes (approximately 70%)

were single-vehicle crashes (involving only the bicycle), with less than 10% involving pedestrians. Of all the self-reported pedestrian-cyclist crashes, the largest number occurred on bike paths (including shared paths), representing 18% of bike path crashes and 68% of pedestrian-cyclist crashes. The number of pedestrian-cyclist crashes on footpaths was similar to the number on urban roads. Footpath crashes (like bike path and off-road crashes) resulted in less serious injuries to cyclists than crashes on urban roads. The lower frequency and severity of footpath crashes is consistent with the finding of Kiyota, Vandebona [3] that the average speed of cyclists on the footpath dropped from about 12 km/h when there were no pedestrians present to about half that value when there were six pedestrians within 20 metres of the bicycle.

Several studies have attempted to characterise the extent and nature of pedestrian-cyclist interactions. Early observational research examined bicycle-pedestrian interactions on footpaths in Victoria, where adults are not permitted to ride on the footpath unless accompanying a child [10]. Pedestrians were more likely to encounter cyclists travelling on footpaths adjacent to arterial roads and in shopping precincts, with the majority of the cyclists on the footpaths being adolescents.

Most traffic conflict studies in the recent years have analysed safety by looking at conflicts between vehicles [e.g., 11-14]. Some studies have examined the traffic conflicts between vehicles and bicycles [e.g., 15] and vehicles and pedestrians [e.g., 16]. However, relatively little attention has been given into understanding the conflicts between cyclists and pedestrians. An Australian study [17] used observational data to identify conflicts between pedestrians and bicyclists on 10 shared paths in three cities in New South Wales but the sites were mostly parks and shared paths on bridges. Similarly, Hatfield and Prabhakharan [18] also focused their observations on shared paths. To address the lack of empirical data regarding pedestrian-cyclist conflicts, this paper uses observational data collected in the Brisbane city centre in 2010 in 2012 to explore the prevalence of pedestrian-cyclist conflicts and the factors associated with their occurrence in a busy area.

Method

Data collection

Observations were conducted on Monday to Thursday of the first week of October in 2010 and 2012, during the hours of 7-9am, 9-11am, 2-4pm, and 4-6pm to capture commuter cycling trips, as well as the short trips that are the target of the Brisbane bicycle hire scheme (CityCycle). The observation periods occurred during the school term and did not include any public holidays. The data collected during 2010 occurred during the first week CityCycle bicycles were available for hire, however relatively few docking stations and bicycles were operational. Data collection was repeated in 2012 to measure whether there was any increase in cycling due to the introduction of CityCycle. One observation period was rescheduled to the same time and day of the following week due to rain (Thursday 4-6pm, 2012). The project received approval from the Queensland University of Technology Human Research Ethics Committee (approval no. 1000000937).

Six mid-block CBD observations sites were chosen: Ann St outside Central Railway Station, Eagle St opposite Riparian Plaza, Adelaide St outside City Hall, George St between Ann and Turbot Sts, William St outside the Old Treasury Building and Albert St between Margaret and Mary Sts. All sites are near CityCycle docking stations, and considered to be routes to key destinations in the city. The selection of sites included locations with varying geometric features: different footpath widths, the presence or absence of on-road bicycle facilities, one-way and two-way traffic, and a range of pedestrian volumes (summarised in Table 1).

Table 1. Characteristics of observation sites

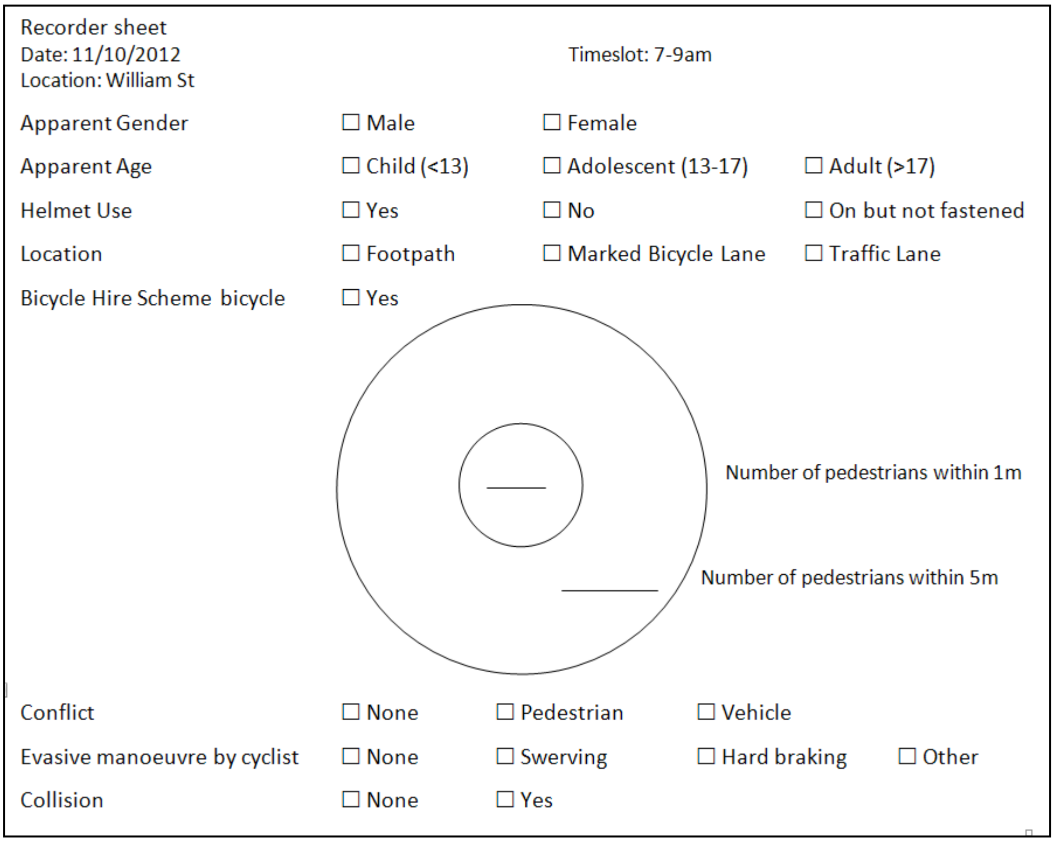
Sites	Traffic direction	No. of traffic lanes	On-road Bicycle Markings	Pedestrian Volume
Adelaide St	Two-way	2	Bicycle Awareness Zone markings	High
Albert St	Two-way	3	None	Medium
Ann St	One-way	4	None	Medium
Eagle St*	Two-way	5	None	Low
George St	One-way	4	Bicycle Awareness Zone markings	Low
William St	Two-way	5	None	Low

*Location shifted 150m north between 2010 and 2012, as pedestrian traffic lights were installed at 2010 location. All other locations remained the same.

Traffic conflicts data have traditionally been collected by human observers who identify and rate conflicts by observing road users' movements and range of evasive actions taken, until the recent developments in automated video analysis techniques [e.g., 19, 20]. As discussed earlier, most traffic conflicts studies have looked at vehicle-vehicle, vehicle-bicycle, and vehicle-pedestrian conflicts. A probable reason why none have looked at the conflicts between pedestrians and cyclists using the automated video analysis techniques is that identifying and tracking movements of pedestrians and cyclists in high density areas (e.g., footpaths, city centres) could be more difficult and resource-intensive than tracking vehicles or bicycles on roadways and intersections. Furthermore, because of overlapping pixels among pedestrians walking in close proximity in a city centre, it is likely to have significant amount of errors in the tracked trajectories of the pedestrians. Therefore, the field-observer method of conflict data collection was adopted in the current study. A simple form was developed for recording observations (see Figure 1). The variables collected for each observed cyclist included: apparent gender, apparent age (child, adolescent, adult), helmet use; and location of cyclist (road or footpath). The number of pedestrians within a 5 metre radius was estimated as a measure of pedestrian density and the number of pedestrians within 1 metre of the cyclist was counted as an indicator of potential for collision. Any conflict between cyclists and motor vehicles or pedestrians was also noted.

Observers received training prior to conducting observations to maximise consistency between observers. At each site an unmarked reference line perpendicular to the roadway and footpath between two identifiable points on buildings was identified by the researchers and demonstrated to the observers. The observers were instructed to record all bicycles (and the presence of pedestrians) at the moment the rider crossed this line. This approach was taken to simplify the task for the observers because cyclists can easily move between the road and footpath, and the presence of pedestrians could change. The observers stood away from this unmarked line and so their presence did not impede or alter the path taken by cyclists or pedestrians.

Conflict was defined as: "where a collision would be imminent unless one or more road users did not undertake an evasive manoeuvre". An evasive manoeuvre, such as hard braking or swerving (as an isolated action, or accompanied by shouting, bell ringing or horn honking), may have been taken by the rider or by another road user. However, only evasive manoeuvres by the cyclist were recorded. The definition of a conflict was deliberately simplified, given the potential for high bicycle traffic in some locations and the potential for large groups of cyclists to pass the observation point together, and observers were not asked to describe the conflict. Observers recorded only those cyclists who were riding at the time, with no records made of people walking bicycles.


Recorder sheet
Date: 11/10/2012 Timeslot: 7-9am
Location: William St

Apparent Gender	☐ Male	☐ Female	
Apparent Age	☐ Child (<13)	☐ Adolescent (13-17)	☐ Adult (>17)
Helmet Use	☐ Yes	☐ No	☐ On but not fastened
Location	☐ Footpath	☐ Marked Bicycle Lane	☐ Traffic Lane
Bicycle Hire Scheme bicycle	☐ Yes		

Number of pedestrians within 1m

Number of pedestrians within 5m

Conflict	☐ None	☐ Pedestrian	☐ Vehicle	
Evasive manoeuvre by cyclist	☐ None	☐ Swerving	☐ Hard braking	☐ Other
Collision	☐ None	☐ Yes		

Figure 1. Bicycle observation data collection form

Analysis methods

To examine the usage patterns of bicycles in the city area and to understand the factors influencing the safety in bicycle-pedestrian interactions, a two stage analysis approach was undertaken in this study. First, a descriptive analysis of observational data on bicycle usage and potential conflicts involving pedestrians was conducted in order to understand the general characteristics of bicycle usage and how these are associated with conflict occurrence. Chi-square tests were conducted to determine any difference in the patterns of data between 2010 and 2012. Second, a regression model was formulated to examine the factors influencing the occurrence of conflicts involving bicyclists and pedestrians. Each observed bicyclist in the dataset could have two possible outcomes: not involved in a conflict, and involved in a conflict with a pedestrian. These outcomes can be well formulated as a binary logistic model by using the binary outcomes conflict (=1) and no-conflict (=0) as the response variable. To account for potential correlations among observations within each observation location, a random effects binary logistic model formulation (where the conflict observations are nested within the observation locations) is also considered. A set of explanatory variables (see Table 5) describing the characteristics of the bicyclists, locations of observation, and time of observation was included in the model.

To identify the subset of explanatory variables which yield the most parsimonious model, a backward elimination procedure was employed to eliminate the non-significant variables one by one so that the Akaike Information Criteria (AIC) was minimized. Significance of the explanatory variables was examined by using the z-test. To evaluate if the model have sufficient explanatory power, likelihood ratio statistics (G^2) was computed.

Results

Descriptive statistics

A total of 1,992 cyclists were observed in 2010, and 2,552 cyclists were observed in 2012. Data from incomplete observer records was excluded, leaving 1,971 complete observations in 2010 and 2,551 in 2012. A summary of the observations is presented in Table 2. The majority of observed cyclists were adults (97.7%) and male (84.6%) with almost equal shares in the 2010 and 2012. Most riders were wearing helmets appropriately (97.8%, note that helmet usage is compulsory in Queensland), and travelled on the roadway (77.2%). Only a small proportion of cyclists (3.1%) were observed using CityCycle bikes, which means most riders (96.3%) were riding their own bikes. Tuesday had the highest number of observed riders. The majority of riders were observed travelling during the morning and afternoon peak hours (7-9am: 35.8%, 4-6pm: 39.5%), although approximately a quarter of observations were made outside the peak hours.

Among the 1032 cyclists observed riding on the footpath, 24.4% had one or more pedestrians within 1 metre and an additional 303 cyclists had one or more pedestrians within 1-5 metres. However, the majority of bicycles (98.3%) were not involved in conflicts with pedestrians or motor vehicles. There were 48 observed conflicts between pedestrians and bicyclists and 27 conflicts between pedestrians and vehicles. As expected, cyclists riding on the footpath were more likely to experience a conflict with a pedestrian, while those travelling on the road were more likely to experience a conflict with a vehicle (χ^2= 92.732, p <0.01) (see Table 3).When comparing 2010 and 2012, there were no significant differences in age, gender, use of helmets, involvement in conflicts, or time of day bicycles were ridden. A greater proportion of cyclists were observed travelling on the footpath in 2012 than in 2010 (χ^2= 77.066, p <0.01). A greater proportion of cyclists used public hire bicycles in 2012 (χ^2= 44.432, p <0.01).

In order to focus on conflicts between pedestrians and bicyclists, the dataset for calibration of the regression model excluded the 27 observations where a pedestrian was involved in a conflict with a vehicle. Before estimating the model parameters, conflicts rates in the observation sites were examined first (see Table 4). Overall, 1.1% of all observations resulted in conflicts between pedestrians and cyclists. The Ann St site had the highest rate of conflicts (2.2%) among all sites, whilst it had the second lowest number of observed cyclists (n=543). In contrast, Adelaide St had the lowest rate of conflicts (0.4%), despite having the highest number of observed cyclists (n=1139). The second lowest rate of conflicts (0.6%) was seen in George St, which also had the lowest number of observed cyclists (n=512). William St and Albert St had similar conflict rates and numbers of observed cyclists.

Table 2. General characteristics of cyclists observed

Variable		**2010** (n=1971)	**2012** (n=2551)	**Total** (n=4522)
Gender	Male	1683 (85.4%)	2144 (84.0%)	3827 (84.6%)
	Female	288 (14.6%)	407 (16.0%)	695 (15.4%)
Age	Adult	1928 (97.8%)	2493 (97.7%)	4421 (97.7%)
	Child (up to 17yrs)	43 (2.2%)	58 (2.3%)	101(2.2%)
Helmet use	Wearing a helmet	1925 (97.7%)	2497 (97.9%)	4422 (97.8%)
	Helmet on, but not fastened	25 (1.3%)	30 (1.2%)	55 (1.2%)
	Not wearing a helmet	21 (1.1%)	24 (0.9%)	45 (1.0%)
Riding location choice	Riding on road	1541 (78.2%)	1949 (76.4%)	3491 (77.2%)
	Riding on footpath	430 (21.8%)	602 (23.6%)	1032 (22.8%)
Public or private bicycle	Private bicycle	1947 (98.8%)	2437 (95.5%)	4384 (96.3%)
	CityCycle bicycle	24 (1.2%)	114 (4.5%)	138 (3.1%)
Day of week	Monday	374 (19.0%)	674 (26.4%)	1048 (23.2%)
	Tuesday	587 (29.8%)	675 (26.5%)	1262 (27.9%)
	Wednesday	510 (25.9%)	601 (23.6%)	1111 (24.5%)
	Thursday	500 (25.4%)	601 (23.6%)	1101 (24.3%)
Time of day	7-9am	659 (33.4%)	958 (37.6%)	1617 (35.8%)
	9-10am	216 (11.0%)	245 (9.6%)	461 (10.2%)
	2-4pm	309 (15.7%)	349 (13.7%)	658 (14.6%)
	4-6pm	787 (39.9%)	999 (39.2%)	1786 (39.5%)
Observation site	Adelaide St	402 (20.4%)	742 (29.1%)	1144 (25.3%)
	Albert St	376 (19.1%)	440 (17.2%)	816 (18.0%)
	Ann St	285 (14.5%)	265 (10.4%)	550 (12.2%)
	Eagle St	332 (16.8%)	452 (17.7%)	784 (17.3%)
	George St	259 (13.1%)	253 (9.9%)	512 (11.3%)
	William St	317 (16.1%)	399 (15.6%)	716 (15.8%)
Observed conflict	No conflict	1938 (98.3%)	2509 (98.4%)	4444 (98.3%)
	Conflict with pedestrian	21 (1.1%)	27 (1.1%)	48 (1.1%)
	Conflict with vehicle	12 (0.6%)	15 (0.6%)	27 (0.6%)

Table 3. Bicycle conflict according to riding location

	Riding on footpath (n= 1032)	Riding on road (n=3490)
No Conflict	993 (96.2%)	3454 (99.0%)
Conflict with pedestrian	38 (3.7%)	10 (0.3%)
Conflict with vehicle	1 (0.1%)	26 (0.7%)

Table 4. Pedestrian-cyclist conflicts by observation sites

Site	No. of conflicts	No. of non-conflicts	Total no. of obs.	% conflicts
Adelaide St	5	1,134	1,139	0.44
Albert St	11	795	806	1.36
Ann St	12	531	543	2.21
Eagle St	7	774	781	0.90
George St	3	509	512	0.59
William St	10	704	714	1.40
	48	4,447	4,495	1.07

Regression model estimates

Before estimating the regression model parameters, correlations among explanatory variables were examined first. Categorical variables of 'Observation site id' was attempted to include in the Binary Logistic model, but these variables were correlated with other explanatory variables. For example, Ann St was correlated with speed limit and traffic direction variables, average width of footpath was correlated with William St and George St, number of lanes was correlated with William St, and presence of taxi stand was correlated with Eagle St. Because of these correlations, the 'Observation site id' variable was not included in the model. Traffic direction and presence of taxi stands variables were also correlated, so the later was removed from the model.

The parameters of the formulated binary logistic model (BLM) were derived using the maximum likelihood estimation method in the software STATA 11.2. Estimation results of the random effects binary logistic model (REBLM) yielded an Intraclass Correlation Coefficient (ICC) value close to zero (with a p-value of 1.0 in a Likelihood-ratio test of the null hypothesis: ICC=0). The ICC value suggested that the REBLM is not superior to the BLM in the case of modelling the current dataset, i.e., there are no significant within-observation-location correlations available in the observed cyclist data. The parameter estimates of the BLM, odds ratios (O.R.), and their statistical significance, are presented in Table 5. The best-fitted model had an AIC value of 400.4. The likelihood ratio statistics value of 160.9 (14 *df*) was well above the critical value for significance at the 1% significance level, implying that the model had sufficient explanatory power. The estimation results of the model parameters are discussed in the subsequent paragraphs.

No significant statistical evidence was found to support the argument that the probability of conflict increased from 2010 to 2012, although the number of bicyclists observed in 2012 was 29.4% greater than in 2010. This result implies that despite the increase in bicycle use, the safety of pedestrians and cyclists has not worsened.

Conflicts were likely to be significantly higher during the periods 7-9am (O.R. = 4.2) and 2-4 pm (O.R. = 5.7), compared to the period 4-6 pm. The corresponding result for the 9-11 am period was statistically non-significant.

Table 5. Explanatory variables and estimates of regression model

Explanatory variables	Categories	Beta	O.R.	p-value
Year	0: 2010, 1: 2012	-		
Time of day				
	7-9am	1.444	4.238	0.002
	9-11am	0.635	1.887	0.335
	2-4 pm	1.739	5.694	<0.001
	4-6pm	Ref		
Age	0: Adult, 1: Young	-		
Gender	0: Male, 1: Female	-0.957	0.384	0.060
Helmet use	0: No, 1: Yes	-0.965	0.381	0.057
Bicycle Hire Scheme	0: No, 1: Yes	-		
Location of riding				
	Marked bicycle lane	-0.335	0.716	0.760
	Traffic lane	Ref		
	Footpath	1.884	6.580	<0.001
Bicycle Marking				
	Yellow painted bicycle marking	1.120	3.065	0.010
	Bicycle lane	-1.574	0.207	0.040
	No bicycle marking	Ref		
Traffic direction	0: one way, 1: two way	2.552	12.831	0.001
Presence of bus stops	0: no, 1: Yes, within 150 m	-		
Presence of taxi stops	0: no, 1: Yes, within 150 m	Cor.		
Speed limit of road	0: 40 km/h, 1: 60 km/h	2.796	16.384	<0.001
Observation site id	1 to 6 as categorical variable	Cor.		
No of ped. in 1 m	Continuous variable	0.582	1.790	<0.001
No of ped. in 5 m	Continuous variable	0.106	1.112	0.110
Total number of lanes	Continuous variable	0.471	1.601	0.008
Average footpath width	Continuous variable	-		
Constant		-10.649		<0.001
Model statistics				
No. of observations		4495		
LL(null)		-265.6		
LL(model)		-185.2		
df		15		
AIC		400.4		
G^2		160.9	14 *df*	<0.001

- Non-significant variable, not present in the most parsimonious model; Ref: Reference category; Cor.: Variable was correlated with another variable, so was removed from model.

While age of the cyclist was not associated with their likelihood of being involved in a conflict, female riders were found to be less likely (62% lower odds) to be involved in a conflict than male riders (significant at 94% confidence level). Those cyclists who wore helmets appropriately had 62% lower odds to be involved in a conflict than those who either did not wear a helmet or wore it inappropriately (e.g., not fastened). The likelihood of conflict involvement did not differ significantly among the riders who rode private bicycles and those who rode CityCycle bicycles.

Conflicts were more likely to occur on two-way roads than on one-way roads (O.R. = 12.8) and if the road had a higher number of lanes (O.R. = 1.6). Compared to locations with no bicycle marking, conflict occurrence was more likely in locations with yellow painted bicycle marking (207% higher odds) and less likely in bicycle lanes (79% lower odds). As expected, bicyclists riding on the footpath had 6.6 times higher odds of being involved in conflicts than those riding on the road. Results for riding in a marked bicycle lane, average width of footpath, and presence of bus stops in close proximity of observation location were statistically non-significant.

Posted speed limit of the road had the highest effect on conflict probability. The odds of a conflict were 16.4 times higher in a road with 60 km/h limit, compared to one with 40 km/h. Only the Ann St has a 60 km/h limit while the rest have 40 km/h limits.

Higher pedestrian density in close proximity to bicycles (number of pedestrians in 1 metre) increased the probability of conflict occurrence. The odds of conflict increased by 79% for a one-unit increase in pedestrian density. However, pedestrian density in a larger area around bicyclists (i.e., 5 metres) was not found to be significantly influence conflict probability.

Discussion

This study sought to examine the prevalence of pedestrian-cyclist conflicts and the factors associated with their occurrence in a busy area. The results demonstrated that a quarter of the cyclists riding on the footpath had one or more pedestrians within 1 metre and an additional quarter of the cyclists had one or more pedestrians within 1-5 metres. However, less than2% of cyclists were involved in conflict, either with a motor vehicle or pedestrian and none of the observed conflicts resulted in a collision. Cyclists were more likely to be involved in conflict with a pedestrian (48 observed conflicts) than with motor vehicles (27 observed conflicts). The number of conflicts with motor vehicles observed in this study may be limited due to the fact that all observation locations were mid-block, and did not include junctions. The presence of bus stops, and the average width of footpath in the Brisbane CBD, had no effect on the risk of conflict between a bicycle rider and a pedestrian. Riding in a marked bicycle lane was also found to have had no effect, although this may be a residual effect of only one location having a marked bicycle lane.

Increased odds of a pedestrian-cyclist conflict was associated with: male riders, riders not wearing correctly fastened helmets, riding on the footpath, higher pedestrian density (within 1m but not within 5m), morning peak and 2-4 pm (compared with 4-6 pm), two-way roads, roads with more lanes, higher speed limits, and yellow marked bicycle symbols on the road.

While more bicycles were observed during the afternoon peak hours (4-6pm), the likelihood of a rider being involved in a conflict with a pedestrian was higher during the morning peak hours (7-9am) and the afternoon non-peak hours (2-4 pm) than in the afternoon peak hours. Surprisingly, the likelihood of conflicts during the afternoon non-peak hours was more than that of the morning peak hours as well.

The finding that cyclists had six-fold higher odds of being involved in a conflict with a pedestrian when riding on the footpath was expected given previous research [1, 2]. However, it is important to note that while the odds of a conflict were increased, no collisions were observed for more than 500 cyclists riding within 5 metres of pedestrians on the footpath.

No statistically significant relationships were found between the likelihood of conflicts and type of bikes used (private or hired). In addition, no evidence was found that the likelihood of conflicts between the years 2010 and 2012 differs, despite having more observed riders in the later year when the bike hire scheme was more mature than it was in 2010. Collectively, all these findings imply that the safety of pedestrians and cyclists has not worsened even after increase in bicycle usage. Furthermore, these findings indeed carry a positive message towards the safe use of public bikes.

Female riders and those who wear helmets appropriately had lower odds of being involved in conflicts. Perhaps, male riders are faster than females and are take more risks when riding. Appropriate use of helmets might also indicate that these riders are more safety conscious than those who either do not wear a helmet or wear it inappropriately. The lower likelihood of being involved in conflicts, therefore, might be resulted from their higher safety consciousness.

There was a 29.4% increase in observed cyclists from 2010 to 2012 which occurred without a significant change (increase or decrease) to bicycle route facility provisions (either on-road or off-road) in the Brisbane Central Business District. Not only is this increase heartening to transport and health agencies who are promoting active travel, it is also reassuring that the research found that this increase in cyclist numbers was not associated with any significant increase in the likelihood of cyclist-pedestrian conflicts.

This study has a number of limitations. The range of sites was restricted which made it difficult to clearly identify effects of variables such as speed limit, pavement width and whether there was one-way or two-way travel. Given that data collection occurred mid-week within school term, there were few adolescent or child riders who earlier studies (Drummond) suggest may have had a greater likelihood of conflicts with pedestrians. While the use of trained observers allowed for flexibility and minimised privacy restrictions, limited data on the nature of the observed conflicts was able to be collected. Future studies using video analytics promise to provide more detailed information on the trajectories of the conflicting cyclists and pedestrians and potential factors contributing to conflicts.

In conclusion, the current study has demonstrated a large increase in cyclists in the centre of Brisbane, more than 20% of whom are riding on the footpath. While riding on the footpath increases the odds of a pedestrian-cyclist conflict, it remains low and factors associated with the danger from motor vehicles contribute to these odds. This suggests that the footpath is playing an important role as bicycle infrastructure in the centre of the city where motor vehicle density is high. Yet the current research and the published literature demonstrate challenges associated with male, risk-taking and young riders interacting with (especially) older pedestrians. Safer infrastructure and lower speed limits have an important role in encouraging cyclists to ride on the road and thus minimise risks and inconvenience to pedestrians and cyclists.

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